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Certified by

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Acting Under Secretary of Commerce
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PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION under 37 CFR 1.53(b)(2).

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INVENTOR(s)/APPLICANT(s)

LAST NAME	FIRST NAME	MIDDLE INITIAL	RESIDENCE (CITY AND EITHER STATE OR FOREIGN COUNTRY
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TITLE OF THE INVENTION (500 characters max)

NON-CONTACT INLINE CASE TURNING APPARATUS

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ENCLOSED APPLICATION PARTS (check all that apply)

Specification	Number of Pages	16
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METHOD OF PAYMENT

A check or money order in the amount of:

[☒] $160.00 for large entity
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is enclosed to cover the Provisional filing fees.

The Commissioner is hereby authorized to charge any additional fees or credit overpayment under 37 CFR 1.16 and 1.17 which may be required by this paper to Deposit Account 162201. *Duplicate copies of this sheet are enclosed.*

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No
☐ Yes, the name of the Government Agency and the Government Contract Number are:

Respectfully submitted,

William G. Bruns

William G. Bruns, Reg. No. 19,541

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SPECIFICATION

To All Whom It May Concern:

Be It Known That I, Brian E. Neville, a citizen of the United States, resident of the City of Glen Carbon, County of Madison, State of Illinois, whose full post office address is 14 Williamsburg Lane, have invented certain new and useful improvements in

NON-CONTACT INLINE CASE TURNING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to an article turner assembly for turning conveyed articles. More particularly, the invention relates to an apparatus and method for the in-line turning of selected articles without contact or bumping

2. Background of the Invention

Article turner assembles are well known for turning conveyed articles, i.e., for rotating the articles a designated amount, usually 90°, as they are conveyed along a path. Article turner assembles have many applications in a variety of article handling applications. For instance, an article turner assembly often is used as part of a pattern former of a palletizer.

Known article turning devices have operating and structural characteristics which make them undesirable for use with many products and packages. Present day high speed conveying operations make any slow down in movement along the line or any shut-down of the line caused by package or product deterioration unacceptable.

Some article turner assemblies require contact between the operative element of the article turner assembly and a front and/or side surface of the article to turn the article. Article turner assemblies of this type are called "bump" or "turnpost" turners. In this type of article turner assembly, the article is conveyed so that the front surface of the article contacts a vertically-extending stationary turnpost and spins about the turnpost to effect the desired 90° of article rotation. The article impacts the turnpost with substantial force when the article is conveyed at high speeds. In the usual case in

which the article comprises a package containing goods, this impact may result in substantial abrasion or other marring of the package and may damage goods contained in the package.

Patent No. 6,126,383 uses a diverting mechanism which shoves turned cases to the side at a very high rate of speed. This diverter causes impact and friction to the sides of each turned article, while requiring the bottom of the article to slide across the infeed conveyor. Damage to the contents of the package (e.g., loose glass bottles in a case) is possible, while some soft-sided loose packages (e.g., bundles of paper towels, or stacks of newspapers) may be damaged on the sides or bottoms. Loosely packaged articles may shingle and not shift over at the bottom, causing a faulty turn or no turn at all. This device also relies on guides at the discharge end of the turning mechanism for squaring and centering turned articles, which is another point of potential impact, frictional product damage, or product jams.

Many turners require a significant number of precise adjustments when changing over from one article size to another. Adjustment in conveyor angle, diverter position, horizontal and vertical conveyor position, and speed differential must all be made when products change. Since most users run a variety of different products (sometimes hourly changes) this tedious adjustment and fine-tuning process is not desirable. While settings can be written down and repeated to some extent each time a product is to be run it is a very difficult trial and error process to initially get the settings correct. Automatic linear actuation devices can be utilized to reduce the manual input into article changeover, but this adds significant cost and complexity to the device.

Brewpack Ltd. Of Surrey, England makes a twin mattop belt inline turner which utilizes two side-by-side modular plastic conveyor belts, commonly referred to as mattop belts. The device typically consists of a wide belt with a low friction material, and a higher friction narrow belt that runs parallel to the wide belt. Both belts run at constant, but different speeds, so that when an article is in

contact with both belts, the article tends to rotate (however, not about its center of gravity or geometrical center.) Articles are fed onto the turner largely in contact with the wide low friction belt. The narrow high friction belt stays slightly below the level of the wide belt, if the article is to remain unturned. If the article is to be turned, then one or more actuators raise one or more sections of the narrow belt to provide the speed differential required for article rotation. Since most of the article must rest on the wide belt so it is transported in a stable manner when not turned, only one edge is in contact with the narrow high friction belt when the article is to be turned. This style of turner basically references both turned and non-turned articles to one side of the device (the side with the narrow belt.)

A large gap is required between turned/non-turned articles since the sections of narrow belt that raise and lower are relatively long (a turned article cannot be in this section at the same time a non-turned article is.) Articles do not turn about their geometrical centers or their centers of gravity. Articles are referenced to one side of the device upon their exit. This can have a negative impact on the operation of downstream equipment such as slat dividers or pattern forming conveyors. It is desirable to have product exit the turner on the centerline in many applications.

There are several designs for devices that employ the "lift and turn" method of selectively rotating articles. However this is a very slow process, and is not suitable for high-speed inline applications.

US Patent #3,580,379 describes an inline article turning device that utilizes a "slat divider" type method for rotating packages. This type of device is very difficult to accurately control and fine tune. Different article sizes may require different size platens and lane locations that make this an impractical device for use with multiple products.

There are several designs for article turners that consist of multiple parallel conveyors with fixed speed differentials where all articles that pass through the device are rotated.

SUMMARY OF THE INVENTION

The invention comprises an inline case turner and process that selectively rotates articles without impact or contact with their fronts or sides.

These and other objects and advantages of the invention will be apparent hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

In the drawings wherein the numerals and letters refer to like parts wherever they occur:

Figure 1 is a schematic view of the turner of this invention and a component data sheet;

Figure 2 is a fragmentary view of a clutch/brake assembly; and

Figure 3 is a fragmentary plan view of a modification of the invention showing an auto-correct option.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

I. DESCRIPTION OF OPERATION:

The following detailed description illustrates the invention by way of example and not by way of limitation. This description will clearly enable one skilled in the art to make and use the invention, and describes several embodiments, adaptations, variations, alternatives and uses of the invention, including what I presently believe is the best mode of carrying out the invention. As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The inline case turner is a device that selectively rotates articles without impact or contact to their front or sides. The turner is designed to accept a stream of articles with a minimum gap between them, and rotate only those that are programmed to be turned. The device can accept any combination

of turned and non-turned articles and can turn them through angles up to and through 360 degrees. The typical application is to turn selected articles 90 degrees to facilitate to formation of a pallet pattern.

The inline case turner consists of two parallel v-belt live roller conveyors with one motor, two belts, and multiple clutch/brake assemblies. Both sides of the conveyor are driven at the same speed. A series of "snub rollers" force the v-belts against the drive rollers, causing them to rotate when the belt is moving. For straight articles, all the snub rollers on both sides of the conveyor remain pushed against the drive rollers, causing the speed to be the same on both sides. When an article must be turned, the snub rollers on one side drop away from the belt and a brake stops the rollers under the article. When the rollers on one side are stopped and the other side continues to drive, the article tends to turn about its geometrical center (as long as weight is evenly distributed across the bottom of the article.) If items enter the device on the centerline, both turned and non-turned articles tend to be centered upon their exit.

Each clutch/brake assembly consists of a solenoid valve, a guided pneumatic cylinder, a snub roller, a brake pad, and a sensor to detect the article. The pneumatic cylinder is normally extended, with the snub roller pushing against the v-belt to provide drive to the conveyor rollers. As an article progresses through the turner, the sensor associated with each clutch/brake detects it. If the article is to be turned, the solenoid valve shifts and the pneumatic cylinder retracts to brake two rollers under one side of the article. When the article has passed by the stopped rollers associated with the clutch/brake, the solenoid valve de-energizes and drive is restored to the rollers once again.

A predetermined number of pneumatic cylinders will actuate as the article travels through the turner, causing it to rotate through the desired angle. When the article reaches the last cylinder that is to be actuated, a timer starts. When the timer has reached a particular valve that corresponds to a

complete turn, all cylinders that are retracted will extend and drive the rollers under the article once again. As drive is restored to both sides of the conveyor, article rotation halts and it continues to move out of the turner without further angular displacement.

PE101 and SV101 operate the first clutch/brake assembly. PE102 and SV102 operate the second clutch/brake assembly...and so on through PE112 and SV112. PXE101, PXE102, and PE113 are utilized for the optional auto-correct feature.

The auto-correct option give the inline case turner the ability to detect whether or not an article has turned properly as it exits the device. Utilizing this feedback, the device can then automatically adjust its control outputs (timers and number of clutch/brakes actuated) to effect the desired angle of rotation on future turned articles. Auto-correct uses two distance detecting sensors (PXE101 and PXE102) and another sensor to detect when the article is in position for measurement (PE113.) As turned article passes PE113, a snapshot is taken with the distance detecting sensors to determine distances "A" and "B." Since the sensors are known distance apart, and the distances "A" and "B" have been determined, the relative angle of the article can be calculated. Deviations from the desired angle between approximately 1 degree and 15 degrees can be sensed and automatically corrected on future turned articles.

The operator can manually adjust the inline case turner's settings by pressing one of the two buttons on the control station (CSCT.) If the inline case turner is equipped with auto-correct, the operator must first turn the control switch to "manual correct." The manual correction buttons should light up when the device is in manual correct mode. Each time the "increase turn" or decrease turn" button is pressed, the timer controlling the release of the brakes (T_L) will be raised or lowered by one time increment. When the minimum or maximum timer has been reached, the control system will either add or subtract a clutch/brake to the turning sequence, and a new timer will be started. If the

manual correction buttons are pressed for more than 2 seconds, the time increment will run up or down at a faster rate. This feature will speed the tuning process, since there are 100 timer increments between clutch/brake additions. When the articles are within a few degrees of a proper turn, the operator can switch the control back to "auto-correct" and the article turner will complete the fine-tuning process itself.

II. INLINE CASE TURNER PARAMETERS AND CONTROL VARIABLES:

CONSTANTS:

1. Maximum turner speed, SMAX = 175 (ft/min) = 35 (in/s)
2. Clutch/Brake response time = 0.060 (s)
3. Rollers on 2.25" centers
4. Twelve Clutch/Brakes, PE's on 4.5" centers (2 rollers per assembly)
5. Time base must be set to 0.001 (s) in the program for timers to have the correct resolution
6. Distance between PXE101 and PXE102 = 7.5"
7. Distance between PXE102 and PE113 = 2.75"
8. PLC scan time must be less than .005 (s)

VARIABLES:

1. **S** = Measured conveyor speed (in/s)
2. $\mathbf{T_{101\text{-}102}}$ = Time it takes article to get from PE101 to PE102—note: this timer must be set for 0.001 (s) time base to be accurate (s)
3. **L** = Article length (in)
4. **Q** = Initial number of brakes actuated at the same time—dependent upon article length
5. **N** = The total number of clutch/brake cylinders that must be actuated to turn an article.
6. $\mathbf{T_E}$ = The timer that starts after PEx is blocked and must expire before SVx energizes

7. T_D = The timer that starts after PEx clears and must expire before SVx de-energizes
8. T_L = The "Lift timer" is the amount of time past the actuation of the Nth solenoid valve that the brakes remain engaged. After TL times out, all remaining engaged brakes will lift up and drive the rollers under the article even if their photoeyes are still blocked. (s)
9. T_{LMIN} = The smallest value of T_L at a given conveyor speed. Can't be smaller than clutch/brake response time of 0.060 (s)
10. T_{LMAX} = The largest value of T_L at a give conveyor speed.
11. I = Integer input between 100 and 1299 that is input by the operator or auto control function and dictates the number of slides that will be actuated and the amount of time the brakes will be held on.
12. R = Last two digits of "I" that dictate the relative life timer value (between 0-99)
13. A = Distance from PXE101 to article (in)---for auto-correct option only
14. B = Distance from PXE102 to article (in)---for auto-correct option only
15. D = A – B (in)

III. <u>INLINE CASE TURNER SETUP AND CONTROL FORMULAS</u>

<u>Photoeye Placement:</u>

Since the clutch/brake actuator takes approximately 0.060 (s) to raise or lower, the photoeye associated with it must be placed upstream so the brake has enough time to get down before the article gets there when the conveyor is running at maximum speed.

<u>Placement = 35 (in/s) * 0.060 (s) = 2.1 (in)</u>

Place photoeye 2.1" upstream (approximately 1 roller) of the roller to be braked.

Conveyor Speed Calculation:

In order to correctly control the timers it is necessary to know how fast the conveyor is running. Measure the amount of time it takes to get from PE101 to PE102 and divide by the fixed distance between the eyes of 4.5 (in).

$$\underline{S\ (in/s) = 4.5\ (in) / T_{101\text{-}102}\ (s)}$$

Example: If the measured time between PE101 and PE102 = 0.128 (s), then the conveyor speed, S, would be 4.5 (in) / 0.128 (s) = 35 (in/s)

Energize Timer:

If the conveyor speed is less than the maximum speed, then there must be a time delay, T_E, after PEx is blocked before SVx energizes.

$$\underline{T_E\ (s) = .060\ (s) / S\ (in/s) * [S_{MAX}\ (in/s) - S\ (in/s)]}$$

Example: If the measured speed is 30 in/s, then $T_E = .060 / 30 * (35-30) = .010$ (s)

Note: The value .060 is the clutch/brake response time; if S = Smax, then $T_E = 0$

De-energize Timer:

Since PEx is located upstream of the rollers it controls by 2.1", if SVx were de-energized as soon as it were cleared, the rollers would start up while the article was still on them. Since this can cause inconsistent article turning, it is desirable to wait until the article is completely off the rollers before starting them up. The article must travel approximately 6.75" after clearing PEx before it is off the rollers that would be started by de-energizing SVx.

$$\underline{T_D\ (s) = [6.75\ (in) / S\ (in/s)] - .060(s)}$$

Note that we need to subtract out the clutch/brakes response time so the timer is no longer than it needs to be.

Initial Number of Solenoid Valves Actuated:

Since the inline case turner functions by stopping drive on one side of an article and maintaining it on the other side, it is desirable that all the rollers on the non-driven side be stopped under the entire article while it is in the process of turning. This can be achieved initially by waiting until the entire article is on rollers that can be braked, then braking those rollers simultaneously. Q = the number of clutch/brake solenoid valves that this equates to.

$$Q = L\ (\text{in}) / 4.5\ (\text{in}) \qquad (\text{drop the remainder})$$

Example: If the article length entered were 12.5 (in), then Q = 2.77 (drop remainder) = 2

So, in this case, PE1 would be blocked, but SV101 wouldn't energize right away. PE102 would be blocked, then T_E would begin. After T_E has timed out, then SV101 and SV102 would energize at the same time. SV101 would de-energize either when PE101 cleared and T_D timed out, or when PE_N cleared and T_L timed out, whichever came first.

Maximum and Minimum Lift Timer Values:

The minimum value for the lift timer T_{LMIN} is the amount of time it takes for the article to get from the sensor to the first roller that is to be braked. For the maximum speed of 175 fpm or 35 in/s, the time it takes to get from the sensor to the first braked roller is 0.060 (s), since the sensors were set to their position based on the response time of the actuator. With a maximum speed of 175 feet/min, and the photoeyes placed 2.1 inches upstream, T_{LMIN} cannot be less than 0.060 (s) or else the actuator would get the signal to extend before it was finished retracting.

$$\underline{T_{LMIN} = 2.1\ (\text{in}) / S\ (\text{in/s})}$$

Example:

If S = 30(in/s), then T_{LMIN} = 2.1 (in) / 30 (in/s) = 0.070 (s)

The maximum value for the lift timer T_{LMAX} is the amount of time that the brakes can remain engaged after PE_N is blocked. If T_{LMAX} has been reached, and the article has not turned enough, the next clutch/brake downstream should be actuated (with $T_L = T_{LMIN}$.) T_{MAX} is the amount of time it takes the article to travel from PE_N, across the two braked rollers, and to the first turning roller. This distance will be approximately 6.75" for S_{MAX} = 175 fpm.

$$\underline{T_{LMAX} = 6.75\text{ (in)} / S\text{ (in/s)}}$$

Example:

If speed were 30 (in/s), then T_{LMAX} = 6.75 (in) / 30 (in/s) = 0.225 (s)

IV. <u>MANUAL ADJUSTABLITY AND USER INPUT:</u>

The program is set up such that the user inputs a number, "I", between 100 and 1299. For a new article that has not been run yet, the default value will be 650. The last two digits of "I" dictate the relative lift timer value "R". The first digit (or two if over 1000) correspond to the number of clutch/brake assemblies to be actuated. For example, if I = 860, the number of clutch/brakes to be actuated is "N" = 8, and the relative lift timer value "R" = 61 (always add 1 to the last two digits so there can never be a value of zero.) The user can push the "Increase Turn" or "Decrease Turn" buttons to change the value of "I", and thus "N", and "R".

$$N = I / 100 \text{ (dropping the remainder)}$$

$$R = I - (N*100) + 1$$

$$\underline{T_L(s) = ((T_{LMAX} - T_{LMIN})/100*R + T_{LMIN}}$$

Example:

If the user inputs I = 625, and T_{LMAX} = 0.225 (s), and T_{LMIN} = 0.070 (s) then:

N = 625/100 (drop remainder) = 6

R = 625-(6*100)+1 = 26

$T_L(s) = ((0.225\text{-}0.070/100)*26+0.070 = 0.110\ (s)$

Thus, six brakes are actuated, and 0.110 (s) after the sixth sensor is blocked, all brakes that are still down will lift up and drive will be restored to all rollers under the article. If the article has not turned enough, then the user can press the "increase turn" button and increase the value of "I". Conversely, if the article turned too much, the user can decrease "I" by pressing the "decrease turn" button. By plugging numbers into the formulas, it can be seen that T_L will increase in this example until it reaches the value of T_{LMAX}, or 0.225 (s). When the value of "I" reaches 700, the number of brakes actuated will roll to 7 and T_L will equal T_{LMIN}, or 0.070 (s).

V. PROGRAMMING FOR AUTOMATIC CONTROL:

The sensors for the auto-correct function are located at the discharge end of the article turner. As can be seen in Fig. 3, the distance detecting sensors PXE101 and PXE102 are located 7.5" apart, and the location detecting sensor PE113 is located 2.75" downstream of PXE102. When a turned article is detected by PE113, the distance to the article should be recorded in "A" (in) and "B" (in). When the desired angle of turn is 90 degrees, "A" and "B" should be equal. If the article is under-turned, then "A" > "B", and if it is over-turned "A" < "B".

ONLY TURNED ARTICLES SHOULD BE MEASURED BY THE AUTO-CORRECT SENSORS.

D (in) is the difference between A and B.

$$D\ (in) = A\ (in) - B\ (in)$$

When "D" is a negative number, the article has over-turned and the value of "I" must be decreased.

When "D" is a positive, the article has under-turned and "I" must be increased.

Corrective action should be taken, based upon the value of "D", as follows:

ABSOLUTE VALUE OF "D" (INCHES)			CHANGE IN "I"
0.00 ≤	D	< 0.13	0
0.13 ≤	D	< 0.25	1
0.25 ≤	D	< 0.38	2
0.38 ≤	D	< 0.50	3
0.50 ≤	D	< 1.00	10
1.00 ≤	D	< 1.50	25
1.50 ≤	D	< 2.00	50
2.00 ≤	D		100

The program may also be set up to signal a fault if the absolute value of D is above a set number. This will signal that an article is positioned in such a way as to potentially cause a jam situation. The program could then either shut down the machine or take some other preventive action.

Example:

I = 625, And T_{LMAX} = 0.225 (s), And T_{LMIN} = 0.070 (s)

Then, as above, there will be 6 brakes actuated, and 0.110 (s) after PE106 is blocked, all the solenoid valves that are still energized will de-energize.

Suppose that the article comes out of the turner at an angle other than 90 degrees, and the value of A = 8.26 while the value of B = 8.73.

D = 8.26 (in) – 8.73 (in) = -0.47 (in)

Since D is a negative number, the article overturned, and "I" must be decreased by 3 as shown in the chart above.

For the next article that is to be turned, I = 622.

"N" will still be 6, but T_L will have changed to 0.106 (s).

If the absolute value of "D" for then next article is less than 0.13 (in), then no further correction will be necessary. If not, then the above procedure will be repeated.

There it is clear that the present invention provides an inline case turner that is true non-contact device that requires no shifting of either turned or straight products. There is no contact to the sides of articles required while passing through the turning device. While it is possible to utilize guides at the discharge end to ensure product is squared, it is not generally necessary. The only guiding that is necessary is on the conveyor feeding the turner (to ensure product enters on the centerline of the turning device) and even this can be avoided with the use of a centering type conveyor such as a herringbone design. No lateral product shifting is required.

The present inline turner requires no manual adjustment when changing from one product to another, since all adjustable settings are saved within the program. Guides on the conveyer feeding the turner are the only adjustment required in order to center the article on the turner. Initial set-up and fine tuning of each article is simplified by allowing the user to push one of two buttons to either increase of decrease the turn. Also, fine tuning is made automatic when using the auto-correction option.

The present inline turner discharges both turned and non-turned articles on the centerline when they are fed in on the centerline, when the article's weight is evenly distributed, and when the settings are adjusted correctly.

The present inline turner turns rigid and non rigid packages without regard as to whether they have uniform or non-uniform bottoms. It can turn lengthwise and sideways packages full 90+ degrees without contact to the front or sides of the package.

The turner has the ability to automatically monitor every turned article and detect even minute changes in the angle of turn. Furthermore, it can automatically adjust its own settings to fine tune

itself and adapt to changing conditions. Even if the auto-correct feature is not utilized, the turner can be adjusted on the fly by simply pushing the "increase turn" or "decrease turn" buttons until the angle is correct. If auto-correct is enabled, the inline turner has the ability to detect a package that is so poorly turned that it may result in a jam condition. If this is the case, it can send an alarm signal that can either shut down the machine or provide some other preventive action.

The present turner does not use expensive and complicated server drives but instead relies on one single-speed drive and simple pneumatic components that are very easy to troubleshoot, readily available, and inexpensive to maintain or replace. It also can be broken up into independently driven/non-driven sections of as little as one roller. The preferred embodiment breaks the conveyor up into two-roller sections that are either 2.125" or 2.25" apart. This means that a minimum of 4.5" gap is necessary between turned/non-turned articles. Closer spacing of actuators results in a higher degree of turning accuracy and faster throughput. The present control system is simple for the end user to operate, troubleshoot and maintain.

In view of the above, it will be seen that the several objects and advantages of the present invention have been achieved and other advantageous results have been obtained.

Docket No.: ALVY 8781US
Inventor: Brian E. Neville
Title: Non-Contact Inline Case Turning Apparatus
Atty: William G. Bruns **Ph.** 314-872-8118
Express Mail #: EL993297107US

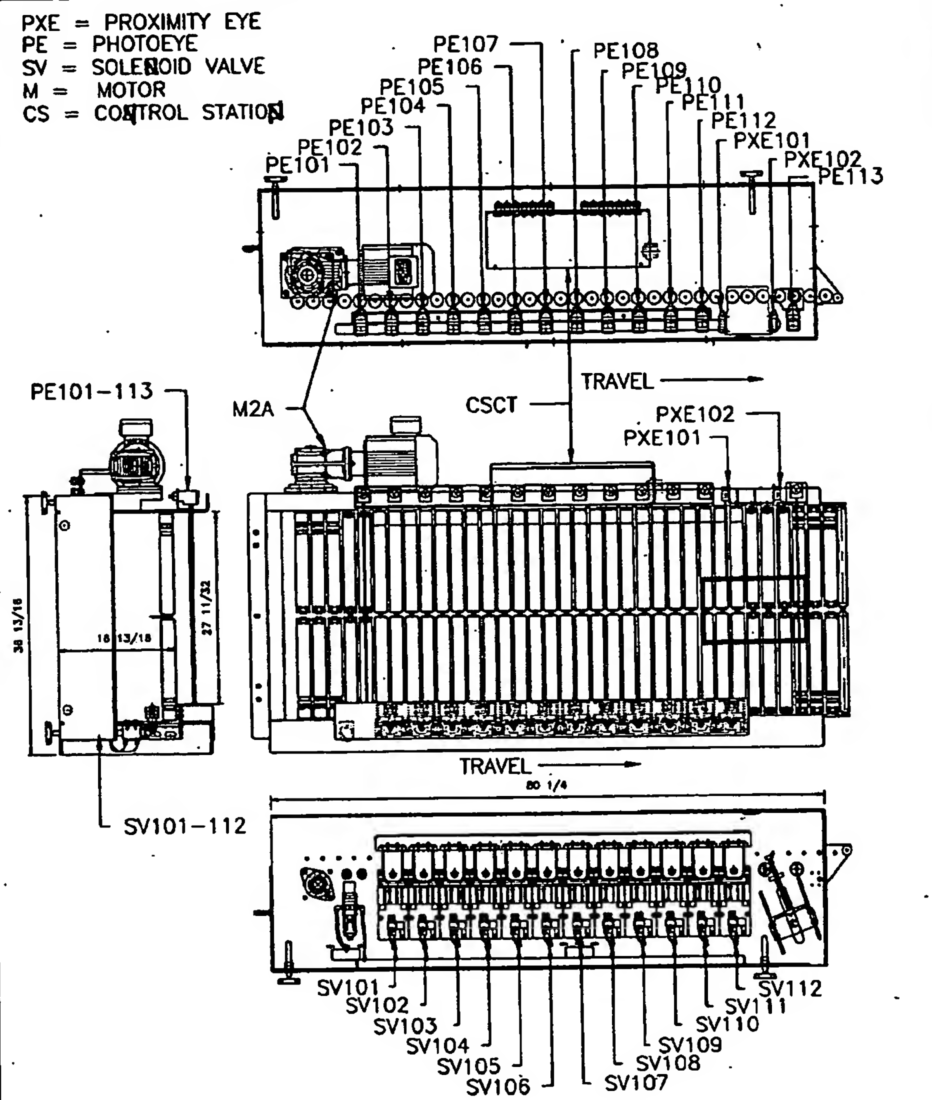

FIGURE 1:
COMPONENT LAYOUT AND DESCRIPTION

Docket No.: ALVY 8781US
Inventor: Brian E. Neville
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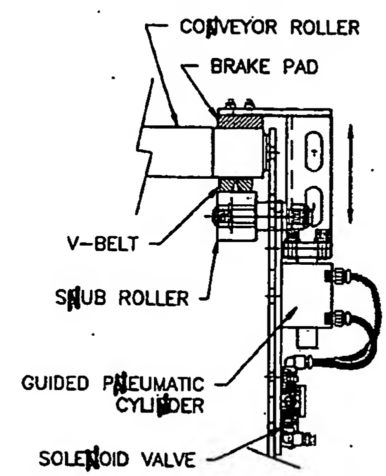

FIGURE 2:
CLUTCH/BRAKE ASSEMBLY

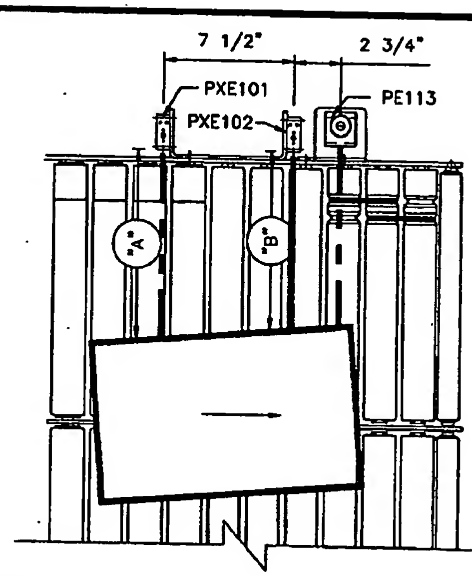

FIGURE 3:
AUTO-CORRECT OPTION

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US04/038249

International filing date: 10 November 2004 (10.11.2004)

Document type: Certified copy of priority document

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Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)